

CLAIMS

1. A noise reduction apparatus for an enclosure, comprising:

error sensor means arranged to generate an error signal;

control means responsive to a reference signal to produce a control
signal;

a transducer responsive to the control signal;

the control means comprising:

a first controller responsive to the reference signal to produce
the control signal for the transducer,

a plant model responsive to the reference signal to produce a
signal input to a second controller,

signal generation means for producing a further error signal
from the output of the second controller, the output of the first
controller and the error signal, and

adaptive means responsive to the further error signal to
adjust the parameters of the first and second controllers
simultaneously.

2. A noise reduction apparatus as claimed in claim 1, further comprising
shaping filter means provided between the signal generation means and
the adaptive means and arranged to process the further error signal and
produce a processed further error signal input to the adaptive means.

3. A noise reduction apparatus as claimed in claim 1 or 2, further comprising
reference sensor means and reference signal conditioning means

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responsive to the reference sensor means to produce the reference signal therefrom.

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4. A noise reduction apparatus as claimed in any one of the preceding claims, wherein the error sensor means is provided adjacent to an operator's head in use.
5. A noise reduction apparatus as claimed in claim 4, wherein the error sensor means comprises two microphones, one provided adjacent each ear of the operator.
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6. A noise reduction apparatus as claimed in any one of the preceding claims, wherein the apparatus further comprises a plurality of transducers and the control means comprises a plurality of controllers each of which is associated with one of the transducers, each controllers producing a control signal for the associated transducer.
7. A noise reduction apparatus as claimed in claim 6, wherein at least one of said controllers comprises a feedforward control channel.
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8. A noise reduction apparatus as claimed in claim 6 or 7, wherein at least one said controllers comprises a feedback control channel.
9. A noise reduction apparatus as claimed in claim 8, wherein the reference signal for each feedback controller comprises a further signal produced by the signal generation means.
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10. A noise reduction apparatus as claimed in any one of claims 6 to 9, wherein the transducers comprise audio transducers and/or vibration transducers.
11. A noise reduction apparatus as claimed in any one of the preceding claims, further comprising monitoring means arranged to monitor the noise level in

the enclosure and disable the control means if the noise exceeds a predetermined threshold.

12. A noise reduction apparatus as claimed in claim 11, wherein said monitoring means resets the parameters of the controllers prior to enabling the control means.

13. A noise reduction apparatus for an enclosure, comprising:

error sensor means arranged to generate an error signal;

control means responsive to a reference signal to produce a control signal;

10 a transducer responsive to the control signal;

the control means comprising:

a first controller responsive to the reference signal to produce the control signal for the transducer,

15 shaping filter means responsive to a user's selection, provided between the signal generation means and the adaptive means and arranged to process the error signal and produce a processed further error signal input to the adaptive means,

20 adaptive means responsive to the processed error signal to adjust the parameters of the first controller.

14. A noise reduction apparatus as claimed in claim 13, wherein said control means further comprises a plant model responsive to the reference signal to produce a signal input to a second controller, signal generation means provided before the shaping filter means for producing a further error signal from the output of the second controller, the output of the first controller

and the error signal, the further error signal being input to the shaping filter means.

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15.A noise reduction apparatus as claimed in claim 13 or 14, further comprising reference sensor means and reference signal conditioning means responsive to the reference sensor means to produce the reference signal therefrom.

16.A noise reduction apparatus as claimed in any one claims 13 to 15, wherein the error sensor means is provided adjacent to an operator's head in use.

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17.A noise reduction apparatus as claimed in claim 16, wherein the error sensor means comprises two microphones, one provided adjacent each ear of the operator.

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18.A noise reduction apparatus as claimed in any one claims 13 to 17, wherein the apparatus further comprises a plurality of transducers and the control means comprises a plurality of channels each of which is associated with one of the transducers, each channel producing a control signal for the associated transducer.

19.A noise reduction apparatus as claimed in claim 18, wherein at least one channel of the control means comprises a feedforward control channel.

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20.A noise reduction apparatus as claimed in claim 18 or 19, wherein at least one channel of the control means comprises a feedback control channel.

21.A noise reduction apparatus as claimed in claim 20, wherein the reference signal for each feedback control channel comprises a further signal produced by the signal generation means.

22. A noise reduction apparatus as claimed in any one of claims 18 to 21, wherein the transducers comprise audio transducers and/or vibration transducers.

5 23. A noise reduction apparatus as claimed in any one claims 13 to 22, further comprising monitoring means arranged to monitor the noise level in the enclosure and disable the control means if the noise exceeds a predetermined threshold.

10 24. A noise reduction apparatus as claimed in claim 23, wherein said monitoring means resets the parameters of the first and second controller prior to enabling the control means.